Kingdom of Saudi Arabia Ministry of Higher Education **Qassim University** Faculty of Engineering Electrical Engineering Dept.	Qassim University جامعة القصيم	**المملكة العربية السعودية** وزارة التعليم العالي **جامعة القصيم** كليه الهندسة قسم الهندسة الكهربائية

MIDTERM #1#

COURSE NAME: MOBILE COMMUNICATION – (EE 463)

DATE: SMESTER 1, 2016-2017

TIME: 2 HOURS

IDEAL SOLUTION

Student's name:	Pin:	Student's signature	Total marks (18)

Important Notes:

1- TIME ALLOWED (2h)
2- THIS EXAMINATION PAPER HAS (5 PAGES), INCLUDING THE COVER PAGE.
3- TOTAL MARKS AVAILABLE (18)
4- MARKS AVAILABLE FOR EACH QUESTION ARE SHOWN IN THE EXAMINATION PAPER. ALL QUESTION ARE NOT OF EQUAL VALUE
5- ALL ANSWERS MUST BE WRITTEN IN INK. EXCEPT WHERE THEY ARE REQUIRED. PENCILS MAY BE USED ONLY FOR DRAWING, SKETCHING OR GRAPHICAL WORK.
6- THIS PAPER MAY NOT BE RETAINED BY THE CANDIDATE.
7- CLEARLY SHOW ALL STEPS AND FINAL ANSWER MUST MAKE SENSE.
8- READ EACH WORD CAREFULLY.

SPECIAL INSTRUCTIONS:

1- CANDIDATES MAY BRING TO THE EXAMINATION: CALCULATORS AND ALL NOTES THEY DEEM NECESSARY.
2- ANSWER ALL QUESTIONS.
3- YOU CAN USE THE REVERSE SIDE OF PAPERS ALSO.
4- ASSUME ANY MISSING VALUES.

Question	Multiple choice questions 5 marks)	Exercise1 : 4 marks	Exercise2 : 9 marks
Marks			

Question (1):-

1. Fading of the received radio signals in a mobile communication environment occurs because of .....
   a) Direct propagation
   b) Multipath Propagation
   c) Bi-path Propagation
   d) None of the above

Ans: b

2. State whether True of False.

i) The cells or subdivisions of a geographical area are always hexagonal.

ii) A land to Mobile call originates through the Telephone exchange.

   a) True, False
   b) False, True
   c) False, False
   d) True, True

Ans: b

3. In..... Frequency Spectrum is divided into smaller spectra and is allocated to each user.
   a) TDMA
   b) CDMA
   c) FDMA

Ans:c

4. In ..... multiple access is achieved by allocating different time slots for the different users.
   a) TDMA
   b) CDMA
   c) FDMA

Ans: a

5. State whether True of False.

   i) In GSM only TDMA is used.

ii) There is zero inter-channel interference in CDMA.

a) True, False
b) False, True
c) False, False
d) True, True

Ans:c

Exercise 1:

If a total of 33 MHz of bandwidth is allocated to a particular FDD cellular telephone system which uses two 25 kHz simplex channels to provide full duplex voice and control channels.

I. Compute the number of channels available per cell if a system uses
   a. four-cell reuse,
   b. seven-cell reuse,
   c. 12-cell reuse.

II. If 1 MHz of the allocated spectrum is dedicated to control channels, determine an equitable distribution of control channels and voice channels in each cell for each of the three systems.

III. Conclude

Solution

Given:
Total bandwidth = 33 MHz
Channel bandwidth = 25 kHz × 2 simplex channels = 50 kHz/duplex channel
Total available channels = 33,000/50 = 660 channels

(a) For $N = 4$,
total number of channels available per cell = 660/4 = 165 channels.

(b) For $N = 7$,
total number of channels available per cell = 660/7 = 95 channels.

(c) For $N = 12$,
total number of channels available per cell = 660/12 = 55 channels.

A 1 MHz spectrum for control channels implies that there are 1000/50 = 20 control channels out of the 660 channels available. To evenly distribute the control and voice channels, simply allocate the same number of voice channels in each cell wherever possible. Here, the 660 channels must be evenly distributed to each cell within the cluster. In practice, only the 640 voice channels would be allocated, since the control channels are allocated separately as 1 per cell.

(a) For $N = 4$, we can have five control channels and 160 voice channels per cell. In practice, however, each cell only needs a single control channel (the control channels have a greater reuse distance than the voice channels). Thus, one control channel and 160 voice channels would be assigned to each cell.

(b) For $N = 7$, four cells with three control channels and 92 voice channels, two cells with three control channels and 90 voice channels, and one cell with two control channels and 92 voice channels could be allocated. In practice, however, each cell would have one control channel, four cells would have 91 voice channels, and three cells would have 92 voice channels.

(c) For $N = 12$, we can have eight cells with two control channels and 53 voice channels, and four cells with one control channel and 54 voice channels each. In an actual system, each cell would have one control channel, eight cells would have 53 voice channels, and four cells would have 54 voice channels.

Exercise 2:

An urban area has a population of two million residents. Three competing trunked mobile networks (systems A, B, and C) provide cellular service in this area.

- ✓ **System A has 394 cells with 19 channels each**
- ✓ **system B has 98 cells with 57 channels each**
- ✓ **system C has 49 cells, each with 100 channels.**

1. Find the number of users that can be supported at 2% blocking if each user averages two calls per hour at an average call duration of three minutes.
2. Assuming that all three trunked systems are operated at maximum capacity, compute the percentage market penetration of each cellular provider.

Given**: the total carried traffic, *A*, is obtained as 23 Erlangs for the mobile networks A, double for mobile network B and 4 times in case of C mobile metwork.**

Solution

System A

Given:

Probability of blocking = 2% = 0.02

Number of channels per cell used in the system, $C = 19$

Traffic intensity per user, $A_u = \lambda H = 2 \times (3/60) = 0.1$ Erlangs

For $GOS = 0.02$ and $C = 19$, from the Erlang B chart, the total carried traffic, A, is obtained as 12 Erlangs.

Therefore, the number of users that can be supported per cell is

$$U = A/A_u = 12/0.1 = 120$$

Since there are 394 cells, the total number of subscribers that can be supported by System A is equal to $120 \times 394 = 47280$

System B

Given:

Probability of blocking = 2% = 0.02

Number of channels per cell used in the system, $C = 57$

Traffic intensity per user, $A_u = \lambda H = 2 \times (3/60) = 0.1$ Erlangs

For $GOS = 0.02$ and $C = 57$, from the Erlang B chart, the total carried traffic, A, is obtained as 45 Erlangs.

Therefore, the number of users that can be supported per cell is

$$U = A/A_u = 45/0.1 = 450$$

Since there are 98 cells, the total number of subscribers that can be supported by System B is equal to $450 \times 98 = 44,100$

System C

Given:

Probability of blocking = 2% = 0.02

Number of channels per cell used in the system, $C = 100$

Traffic intensity per user, $A_u = \lambda H = 2 \times (3/60) = 0.1$ Erlangs

For $GOS = 0.02$ and $C = 100$, from the Erlang B chart, the total carried traffic, A, is obtained as 88 Erlangs.

Therefore, the number of users that can be supported per cell is

$$U = A/A_u = 88/0.1 = 880$$

Since there are 49 cells, the total number of subscribers that can be supported by System C is equal to $880 \times 49 = 43,120$

Therefore, total number of cellular subscribers that can be supported by these three systems are 47,280 + 44,100 + 43,120 = 134,500 users.

Since there are two million residents in the given urban area and the total number of cellular subscribers in System A is equal to 47280, the percentage market penetration is equal to

$$47,280/2,000,000 = 2.36\%$$

Similarly, market penetration of System B is equal to

$$44,100/2,000,000 = 2.205\%$$

and the market penetration of System C is equal to

$$43,120/2,000,000 = 2.156\%$$

The market penetration of the three systems combined is equal to

$$134,500/2,000,000 = 6.725\%$$

Exercise 2